Appl. No. 09/652,820
RCE Submission dated Dec. 9, 2004
Reply to Final Office Action of Sept. 9, 2004

REMARKS/ARGUMENT

The Examiner has rejected claims 16-19 under 35 U.S.C. Section 103(a) as being unpatentable over Oliensis, "Structure from Linear or Planar Motion," IEEE 1996 (the "Oliensis 1996 paper") and Irani, "Multi-Frame Optical Flow Estimation Using Subspace Constraints" (the "Irani paper"). Applicants respectfully traverse.

The Examiner asserts that the Irani paper discloses "computing a projection matrix which is block diagonal between different smoothing windows and which is used to recover the scene structure (Sect. 4)." This is incorrect. The Irani paper does not deal with the recovery of scene structure and is unrelated to the "projection matrix" as discussed in the present invention.

The Irani paper, as specifically discussed in the Specification at pages 4-5, is directed to an extension of the Lucas-Kanade technique. The Lucase-Kanade technique and the Irani technique are what is termed in the art as "optical-flow" approaches to recovering correspondences between successive images. Irani writes what is known as the brightness constancy equation in matrix form as $\Delta = -DI$ where D tabulates the shifts and I reflects the intensity gradients. Irani notes that D has rank 6 for a camera with a known calibration which implies that Δ must have rank 6. Irani applies a multi-image form of the Lucase-Kanade approach to recovering optical flow which utilizes a matrix equation $DI_2 = -\Delta_2$ where the entries of I_2 are the squared intensity gradients summed over the smoothing windows. Due to the added Lucas-Kanade smoothing constraints, the shifts D can be computed. Irani further discloses using the rank constraint on D to determine additional entries for D for the windows where the intensity is constant in one direction.

The present invention does have similarities to optical-flow approaches like the Lucas-Kanade technique. But unlike prior art optical-flow techniques, the present invention is a true direct method. The present invention "can use feature correspondences, if these are available, and/or the image intensities directly." Specification at page 6, lines 13-14. It does match smoothed image patches, like optical-flow approaches, but in stark contrast to such approaches, it exploits the three dimensional rigidity constraint and recovers the structure/motion and correspondence simultaneously. Irani only discloses exploiting the constraint that the intensity

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change matrix has a rank of less than 6. The approach set forth and claimed in the present application exploits the full set of constraints following from known forms of the translational and rotational image flows.
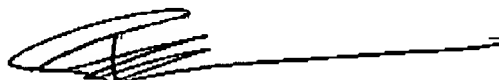
The Irani paper does not disclose utilizing such geometric restrictions to simplify the computational complexity in the manner of the present invention. As discussed in the abstract of the Irani paper, Irani teaches utilizing multi-frame subspace constraints to constrain the correspondence estimation process itself "and **not** for 3D recovery" (emphasis added). Abstract, Irani paper. There is no suggestion in Irani to utilize the linear motion of the successive image data to decompose a shift data representation into a motion vector and a structure vector which can be solved by computing a projection matrix that is block diagonal between different smoothing windows.

As for the Oliensis 1996 paper, the present work by applicant is admittedly an extension of his original work reflected in the Oliensis 1996 paper. The Oliensis 1996 paper, however, is directed to extensions to his original work on tracked point data and does not specifically disclose how to extend his original technique to incorporate image intensity data. Nor, of course, does it disclose any of the other specific steps mentioned by the Examiner.

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Applicants respectfully submit that claims 16-19 represent patentable subject matter. Applicants have added new claims 20-23 which represent device-readable medium claims that directly correspond to the subject matter of claims 16-19. No new matter has been added. Applicants respectfully submit that the application is now in condition for allowance. If the Examiner has any questions, please contact the undersigned at 609 951-2522. Authorization is hereby given to charge any fees which may be required, except the issue fee, to Deposit Account 14-0627.

Respectfully submitted,

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December 9, 2004

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Docket No. 13725 (NECI1086)

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